Appendix F Marine AERI

Introduction

The M-AERI (Marine Atmospheric Emitting Radiance Interferometer) instrument is a version of the standard AERI that has been specifically adapted for marine operation under harsh conditions. It is a self-calibrating, seagoing Fourier-Transform Infrared (FT-IR) spectroradiometer to measure the emission spectra from the sea surface and marine atmosphere.

The M-AERI is designed and built to allow automated operation while mounted externally on a marine vessel, providing protection for exposed components from the corrosive salt air environment. The M-AERI marine-hardened protective enclosure is well suited to protect the instrument against ambient temperature variations from -30°C to +40°C, direct sun exposure, wind, precipitation (rain, sleet, and snow) and water spray or splash.

The M-AERI is an improved ruggedized and reliable instrument for unattended operation under marine conditions. Modifications were made to the front-end protective enclosure, to the scene selection module, as well as to the back-end enclosure. The M-AERI also includes marine-suitable parts to sustain exposition to salt air (ex. connectors, cables, thermoelectric cooler, seals, coatings, etc.).

In summary, the main modifications are:

- A second automated side view-port motorized hatch with precipitation sensor on the front-end enclosure has been added.
- The input scene selection module is adapted for the marine environment with the blackbody source relocated on one side and a hexagonal mechanical structure allowing measurement at zenith, nadir, and slanted angles on one side.
- The front-end enclosure and scene selection module offer reversible installation configuration.
- The back-end precipitation protection enclosure is sealed against the marine corrosive salt air.
- Marine-suitable parts are used to withstand exposition to salt air (ex. connectors, cables, TEC, seals, coatings, etc.)

Key Features

Back-end enclosure

The M-AERI back-end protective enclosure serves to protect and seal the AERI sensor modules (FT-IR, control electronics and signal conditioning modules). This enclosure is temperature controlled by a marine-suitable thermoelectric system (NEMA 4) to prevent heat build-up and maintaining the enclosure's inside temperature at near 20 °C. The external connectors are limited to a power and standard Ethernet connection. The instrument is protected against heat build-up by means of an automated shutdown and restart activation in respect to the internal temperature sensors status being outside or inside the pre-defined temperature threshold values.

Figure F- 1. M-AERI view of the back end TEC coolers

Purge inlet

The M-AERI is equipped with a purge inlet that can be used to purge the back-end enclosure with dry air or nitrogen if the enclosure is exposed to salt air after opening the temperature control unit door or one of its covers. The purge inlet is located on the thermal control door.

Front-end enclosure

The M-AERI front-end enclosure serves to protect the system optics in harsh weather. It protects against direct sun, precipitation (rain, sleet, and snow), wind, and sea spray. It is equipped with two automated view-port motorized hatches, one for atmospheric zenith viewing, and another lateral hatch for side viewing. These motorized hatches automatically close themselves to protect the instrument during precipitation and return to normal operation when the precipitation stops. The M-AERI instrument precipitation and sun sensors manage the opening and closing of the hatches and rotation of the input scene mirror allowing unattended operation 24 h/day, for extended observation periods during marine campaigns. When the hatches are closed, the M-AERI system automatically turns itself into a non-operational safe-mode (rotate mirror to nadir position and remain in stand-by mode).

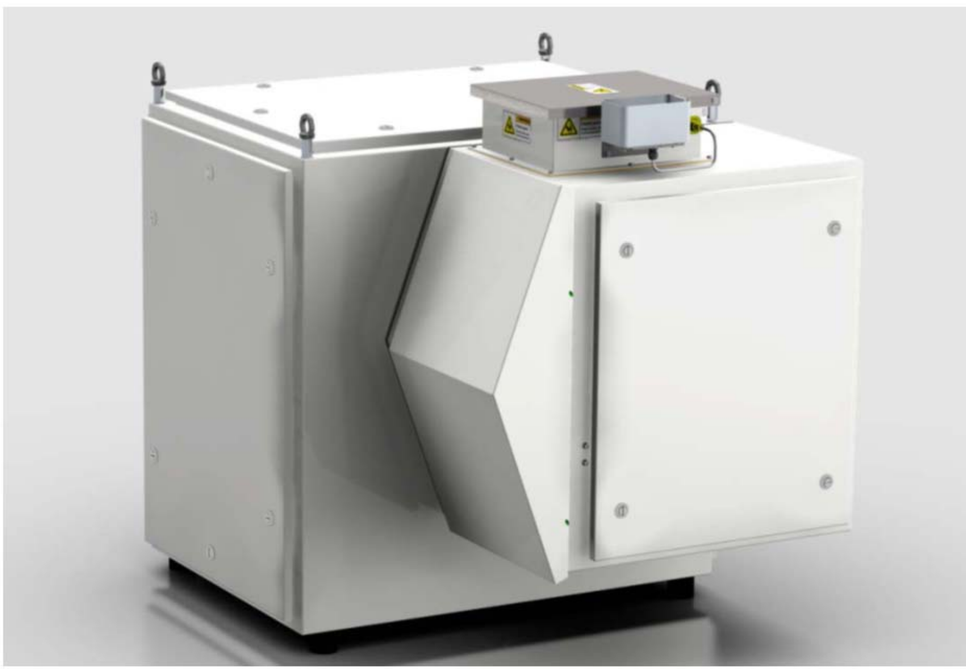

Figure F- 2. Front-end enclosure

FOV Scene Selection Module

The M-AERI system supports typical zenith sky radiance measurements, and, contrary to the standard AERI, also permits slanted views for sea surface measurement. As shown in figure below, the input scene selection module is based on a hexagonal shaped structure with four discrete input ports positions capable of accepting a calibration blackbody at angles of 0, 60, 120, and 180° clock-wise from zenith. These ports present identical input flange aperture compatible to the radiometric calibration sources. In addition to these discrete flanged positions, one side of the hexagonal structure is opened to allow unimpeded view over a continuous scanning FOV from 45° to 135° (or from 225° to 315° counterclockwise from nadir). The calibration sources (HBB and ABB) have been moved to one side of the input scene module in order to clear the FOV on the other side of the input scene module. For the M-AERI, the standard air blowing fan assembly is not used since it would only force salt air into the input scene module.

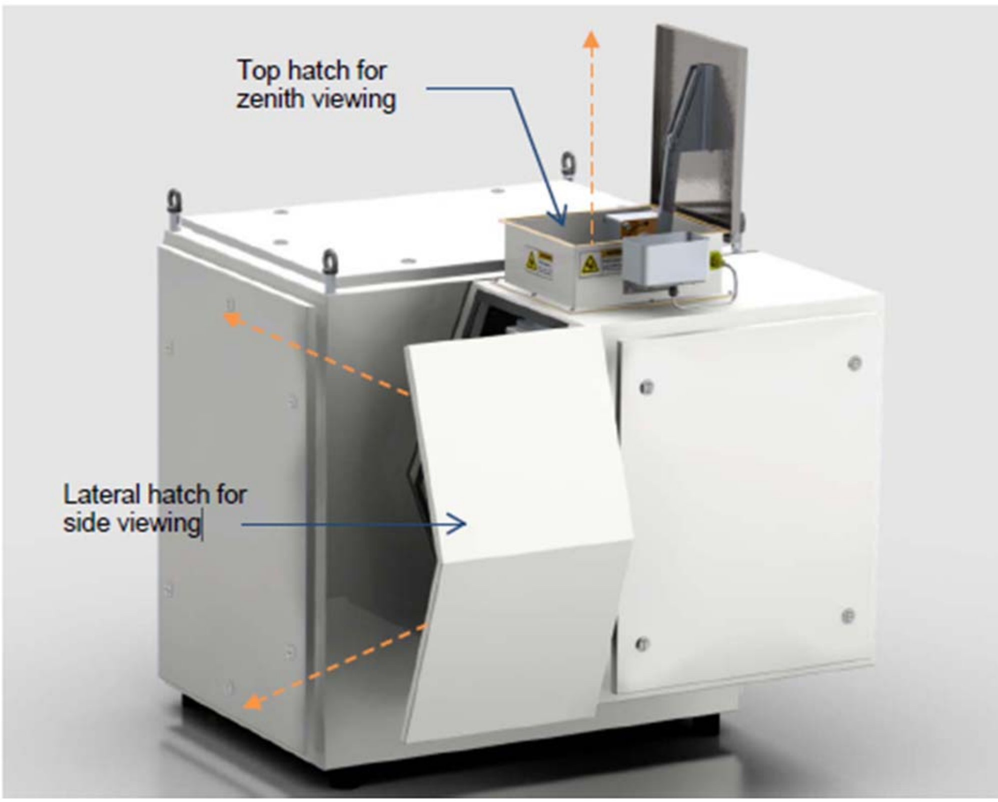

Figure F- 3. Hatches for viewing

The M-AERI is equipped with an internal scene-scan mirror used to direct the instrument field of view to either of the blackbody calibration targets and to the nadir, zenith, and other input positions. The mirror is programmed to step through the various pre-defined input positions accordingly to the sequence defined in a user editable configuration file.

To provide maximum flexibility in terms of sighting and deployment logistics, the M-AERI provides a reversible installation configuration allowing the range of slanted FOV to scan between 45° and 135° or between 225° and 315° (mirror image). The input structure and front-end protective enclosure are designed to be reversible through the mounting points in order to invert the input ports (the attachment points are adapted to allow two mounting configurations with 180° of rotation). This permits installing the input module with reversed input ports viewing the mirror-image of the flanged and unimpeded FOVs. The same mounting principles also apply to the front-end protective enclosure. The open access to the input port is free of obstruction over a 13° FOV from the input scene mirror surface to minimize the possibility of bias measurements.

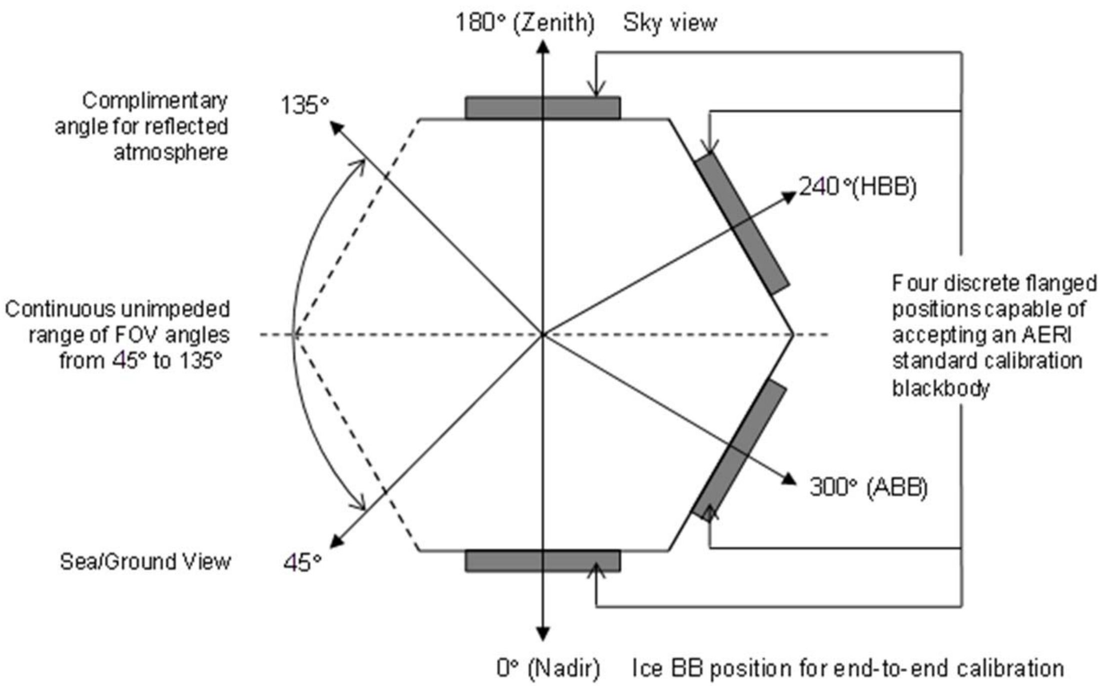

Figure F- 4. FOV Scene Selection Module

Precipitation sensor

The system includes precipitation sensors located on the front-end enclosure and in the side-port opening as shown in figure below. Under precipitation the system will automatically turns itself in a self-protection mode (close input hatch and rotate the scene mirror to the nadir position) that temporarily stops acquisition, returning to normal acquisition mode once the precipitation has stopped.

Figure F- 5. Precipitation sensor location

Sun sensor

The system includes a solar intensity sensor located inside the front-end enclosure as shown in figure below. With the use of a small folding mirror, the sensor always looks in the same direction as the scene mirror. If the solar intensity is too high in the instrument FOV, the system will automatically turns itself in a self-protection mode (close input hatch and rotate the scene mirror to the nadir position) that temporarily stops acquisition, returning to normal acquisition mode once the solar intensity condition changes to favorable conditions.

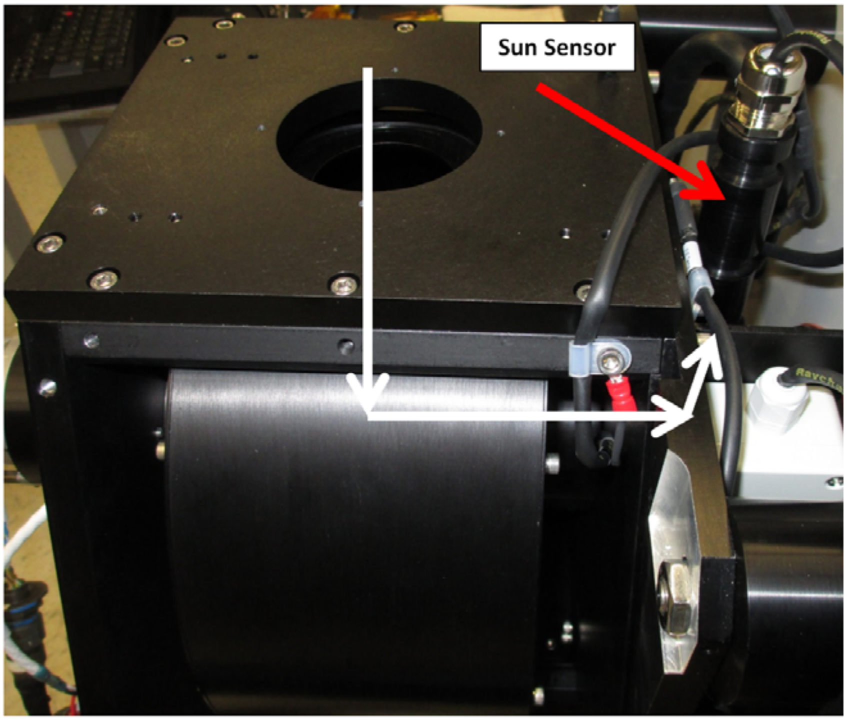

Figure F- 6. Sun sensor

Label

The name plate below is specific to the M-Aeri. This label is located on the inside of the door of the back-end enclosure.

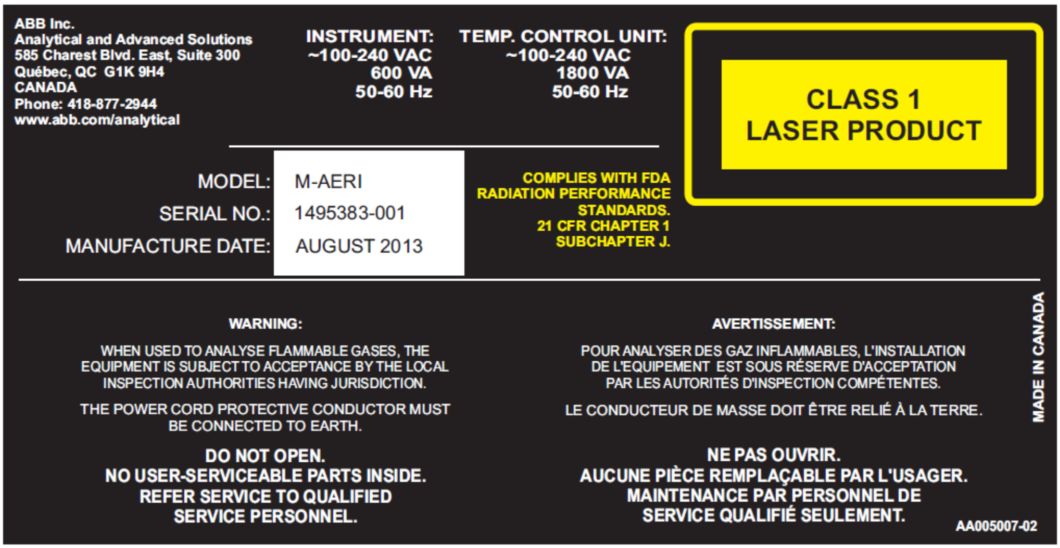

Figure F- 7. Marine-Aeri name plate

Unpacking and installing

Transit case

The Marine AERI is shipped in one travel case which is packed on a pallet and in a wooden box. Make sure to keep the pallet and wooden box for futere shipments (for calibration for example). The dimensions of the travel case are shown on Figure F- 8 below. The accessories (laptop, ethernet switch, cables, etc.) are delivered in a smaller case as shown on Figure F- 9.

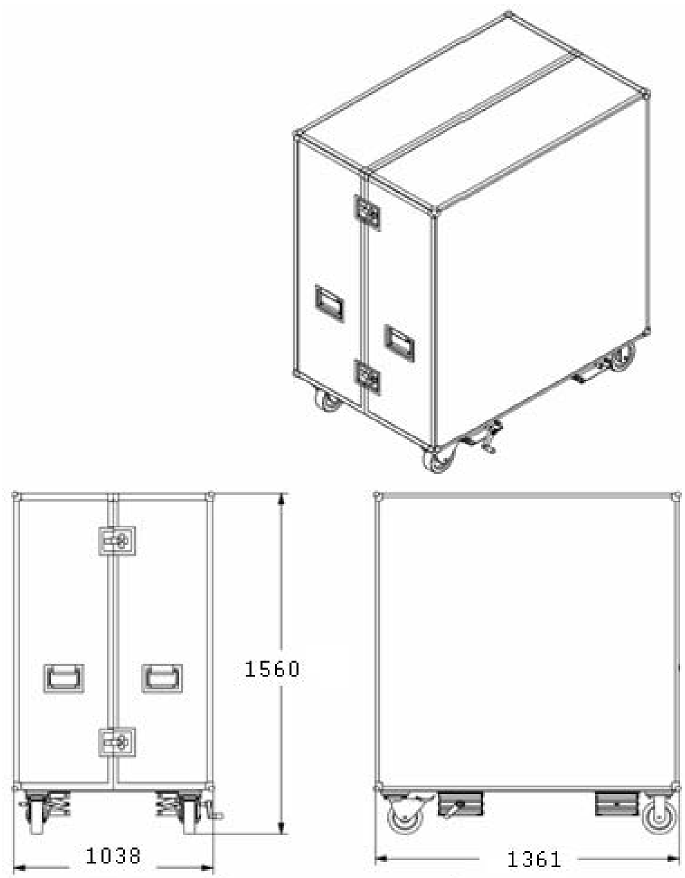

Figure F- 8. Marine AERI Transit Case

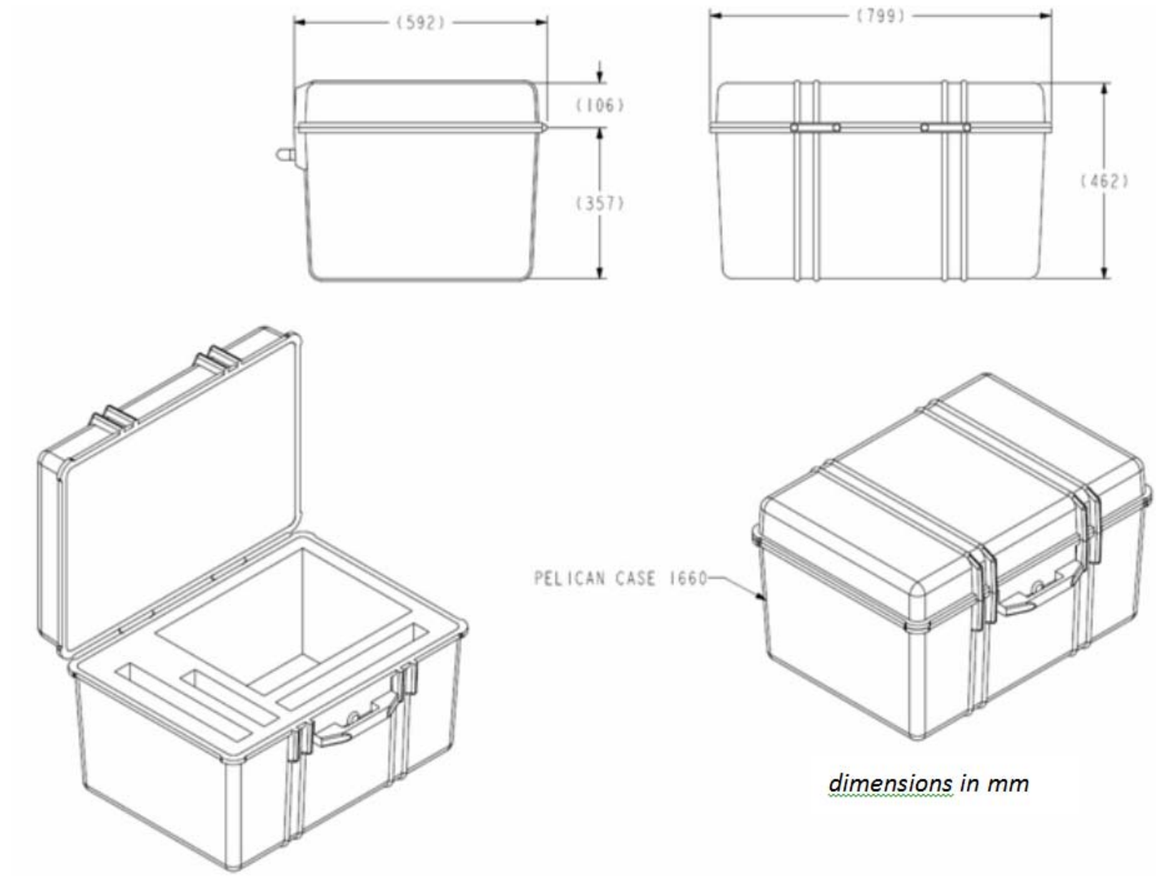

Figure F- 9. Accessories Transit Case

Installation instructions and requirements

The M-AERI weighs 278 kilo (615 lbs). The mounting platform where the instrument is to be installed shall support this weight. The instrument must be lifted using the four lifting bracket on top of the back-end enclosure. These lifting brackets are intended to lift only the instrument. For your safety, do not lift the instrument while it is attached to its dolly.

Electric power of 120-220 volts or 50 to 60 Hz must be available. We recommend two circuits of 120 V, 20A: one for the instrument and the other one for the temperature control. Grounding must be available.

1. Unlatch the transit case and remove both covers by sliding them side way.
2. Attach the lifting hooks to the four lifting bracket to prepare for lifting.
3. Unscrew the screws from the back-end enclosure shockmounts to separate the instrument from its dolly.
4. Lift the instrument and move it to its mounting location. Make sure to secure it by fixing the shockmounts to the mounting platform using screws 3/8"-16 thread. For the shockmount footprint refer to Figure F- 23 and Figure F- 24.
5. Connect the instrument and thermal control unit power cords and the Ethernet cable to the back-end. The cables are in the accessories box.
6. Follow the instructions described in Accessories on page 42 to unpack the accessories box and make the connections between the M-AERI, the laptop, the switched power supply and the Ethernet switch.

Software

Th following temperature readings are not available for the Marine AERI:

- Scene mirror temperature
- Fan airflow temperature
- Protective enclosure temperature

Their status in FTSW AERI will display -265.36 (°C).

M-AERI Instructions

How to reverse the side viewing port

The side viewing port can be reversed to allow an installation where the instrument cannot be installed so the side port is oriented toward the sea. To reverse the side port, the blackbodies and their plate on the input optics hexagonal module need be moved on the opposite side to free the side FOV. The front-end enclosure also needs to be rotated by 180 degrees.

1. Unlatch the front-end panel and remove it.
2. Disconnect the connectors 1J9 (top trap actuator), 1J10 (side trap actuator) and 1J11 (rain sensors) from the interconnect box below the input optics hexagonal module.
3. Disconnect the top trap rain sensor connector from inside the enclosure. From connector 1J11, follow the cable branch going to the top trap rain sensor to find the connector 1J15 to disconnect.

4. Unscrew all 9 x 10-32 and 1 x ¼-20 screws holding the front-end enclosure to the interface plate. The holder plate will help keeping the enclosure in place when all screws are removed. (Some screws are shown in the picture below.)

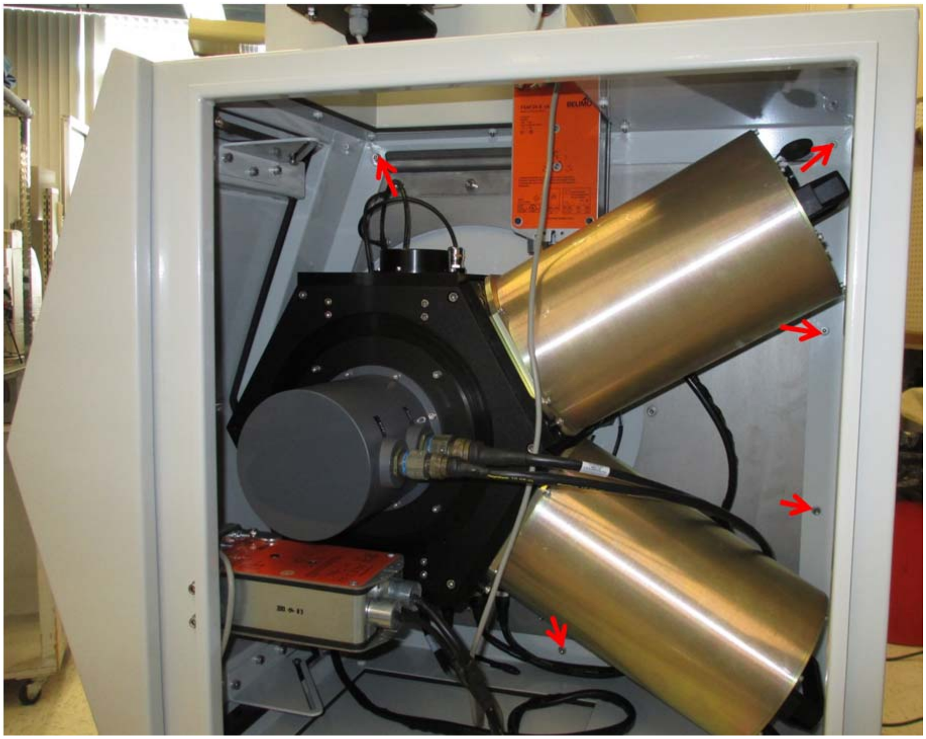

Figure F- 10. Remove front-end enclosure from interface

5. Unscrew the 8 screws holding the top hatch on the front-end enclosure, remove it and put it aside. It will be reinstalled after the front-end enclosure is reversed.
6. Lift the enclosure upward and carefully pull it away from the back panel. Lay the enclosure on a table.
7. Disconnect the connectors on the blackbodies.
8. Remove the blackbodies by unscrewing the 4 screws holding each blackbody to the input optics hexagonal module.
9. Unscrew the 5 screws holding the interface plate to the back-end enclosure.
10. Unscrew the 3 screws holding the holder plate on top of the interface plate and remove it.

11. Carefully rotate the interface plate by 180 degrees going upward with the long part of the plate. Reinstall the 5 screws.

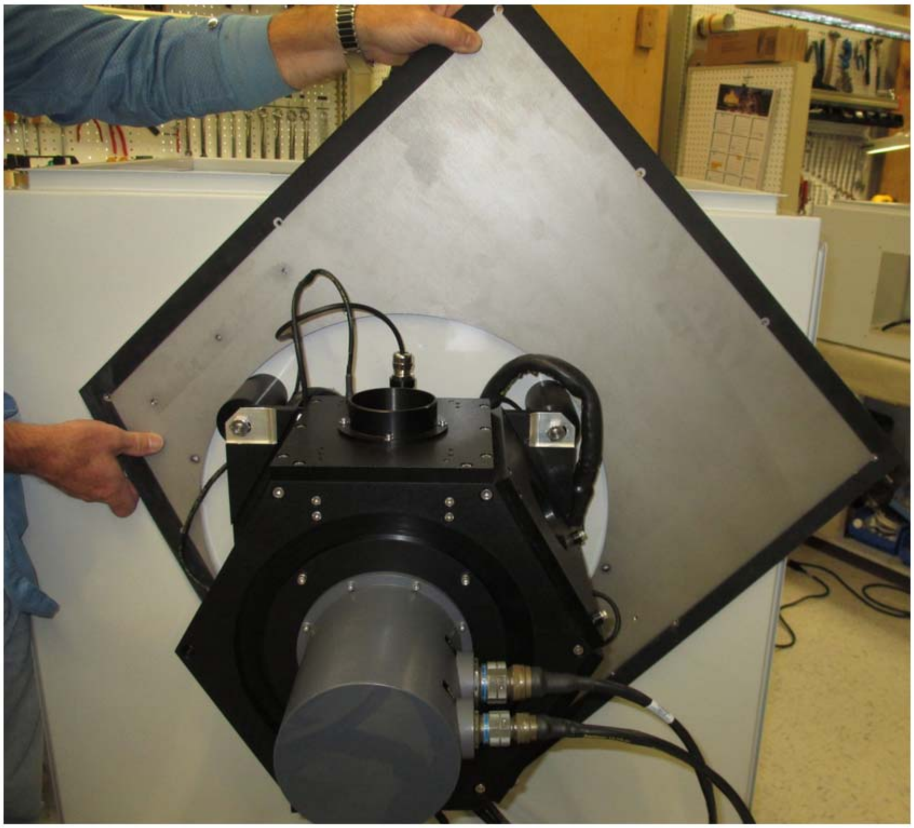

Figure F- 11. Rotate interface plate

12. Do not install a screw where indicated in the picture below, it will be installed with the enclosure in place.

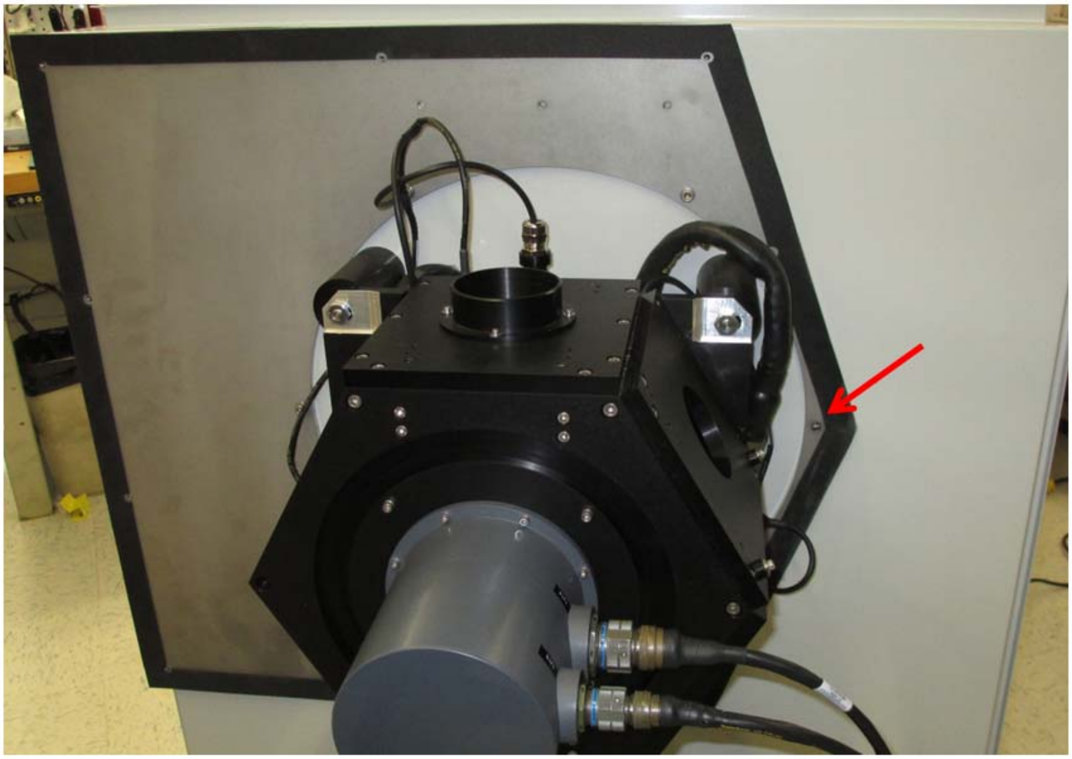

Figure F- 12. Screw not to be installed

13. Install the holder plate on top of the interface plate with its 3 screws.

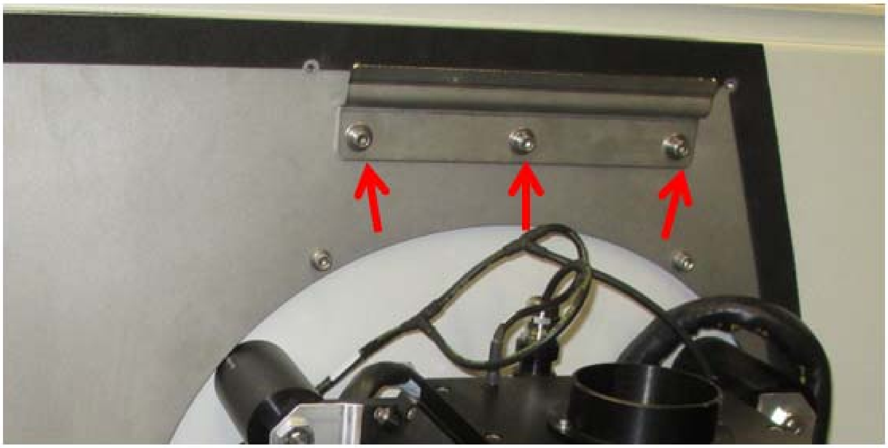

Figure F- 13. Install holder plate

14. Unscrew the 6 screws holding the HBB plate. Remove the plate and put it aside.

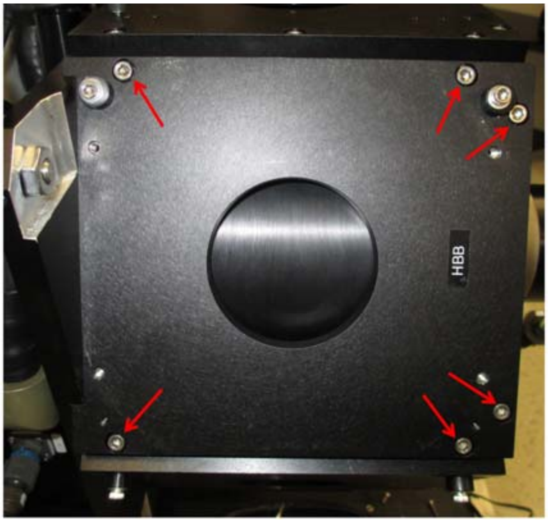

Figure F- 14. Unscrew HBB plate

15. Unscrew the 6 screws holding the ABB plate. Remove the plate and put it aside.
16. Unscrew the screw holding the hexagonal bar between the HBB and ABB plates and reinstall it on the other side but keep the screw loose so it can be rotated to install the blackbodies plate.

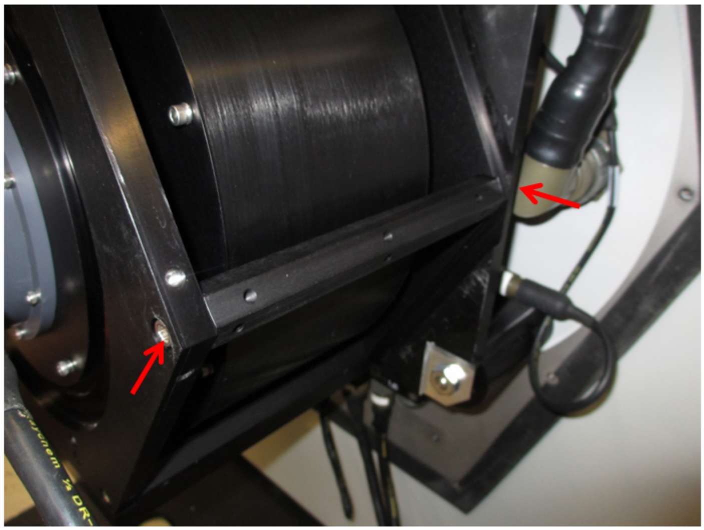

Figure F- 15. Re-install hexagonal bar

17. Unscrew the temperature sensor as shown in the picture below and reinstall it on the opposite side. Flip the cable tie by 180 degree so the cable is away from the scene mirror drum. Make sure that the temperature sensor is floating in the input optic module and does not touch the scene mirror drum.

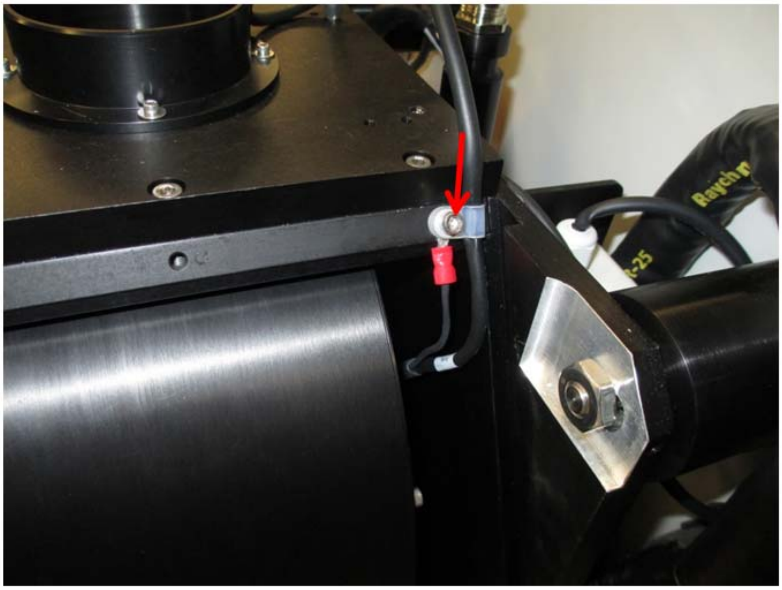

Figure F- 16. Install temperature sensor

18. Install the blackbodies plate on the opposite side, the HBB plate on top and ABB plate below.
19. Tighten the 2 screws of the hexagonal bar between the two plates.
20. Install the HBB on the top side plate with its connector oriented upward.
21. Install the ABB on the bottom side plate with its connector oriented downward.
22. Connect the cables to the blackbodies.
23. On the front-end enclosure put aside previously, remove the enclosure bottom panel by unscrewing the 8 screws and reinstall it on the top opening.
24. Manually open the side viewing port by using an hexagonal key or screwdriver. Refer to section "How to manually open the hatches" for more detailed instructions.

25. Locate the rain sensor as shown in the pictures below.

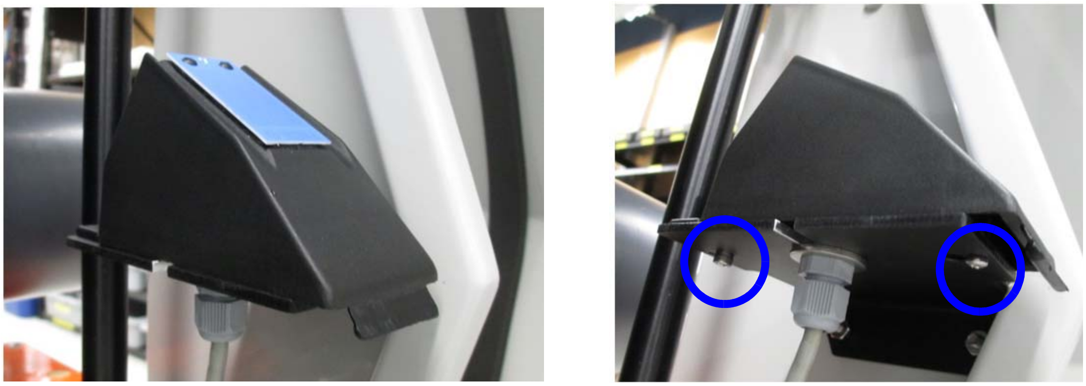

Figure F- 17. Rain sensor

26. Unscrew the philips screw under the bracket holding the sensor.
27. Unscrew the hexagonal screw.
28. Unscrew the cable gland from the sensor cable.
29. Unscrew the cable nut and slide the wires through the slot in the bracket to free the sensor.

30. Turn the sensor upside down and slide the wires through the bracket as shown in the pictures below.

Figure F- 18. Rain sensor re-installed

31. Reinstall the cable nut.
32. Reinstall the cable gland.
33. Reinstall the screws to fix the sensor to its bracket. Do not over tighten the Philips screw.
34. Close the hatch by unlocking the motor, refer to How to manually open the hatches on page 187.
35. Reinstall the front-end enclosure. Put the enclosure so it is held by the holder plate.

36. Install the hatch on top of the front-end enclosure with 8 screws before installing the front-end enclosure screws. The hatch must me oriented so its cover's fixation is on the far side from the side hatch.

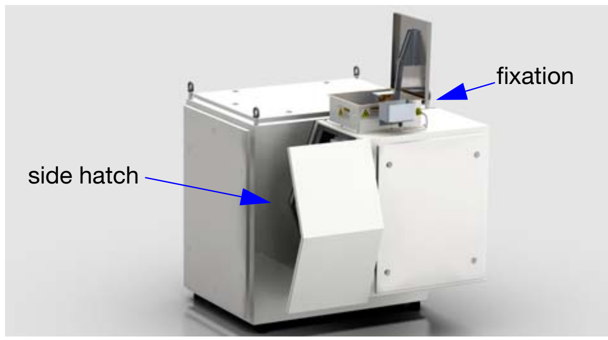

Figure F- 19. Installation of hatch

37. Connect the connectors 1J9 (top trap actuator), 1J10 (side trap actuator) and 1J11 (rain sensors).
38. Fix the front end enclosure with 9 x 10-32 and 1 x ¼-20 screws.
39. Connect the connector 1J15 from the inside of the hatch to the rain sensor.
40. Put the front panel back in place and secure it with the 4 latches.

To finalize the inversion, the FTSW_EAERI configuration file must be changed to tell the software that the blackbodies and side viewing port have changed position.

41. Open C:\E-AERI\FTSW_EAERI.Config and set the flag "Acquire.inputOpticReversed" to "true" or "false" depending on the input optics configuration as described in the comments below.

```
//Flag that determines which mirror angle to use for the ABB & HBB
((mirror.index1Angle & mirror.index2Angle) or
(mirror.reversIndex1Angle & mirror.reversIndex2Angle))
//Set the flag to false when the side viewing port is on the left
when facing the instrument's front-end. Set the flag to true when the
side viewing port is on the right.
Acquire.inputOpticReversed = true
```

Figure F- 20. Config file extract

42. Open C:\config\mirror.beg and replace the angles in the sequence with the new angles for the ABB (mirror.index1Angle or mirror.reversIndex1Angle found in FTSW_EAERI.Config) and HBB (mirror.index2Angle or mirror.reversIndex2Angle found in FTSW_EAERI.Config).

43. In the sequence, replace the side viewing port angles with their equivalent on the other side.

How to manually open the hatches

It is possible to open the hatches manually if the instrument is not powered on.

1. Unlatch the front-end panel and remove it.
2. Insert the provided hexagonal key or an hexagonal screwdriver in the hatch motor you would like to open as shown in the pictures below. An hexagonal hole is available on both sides of the motor

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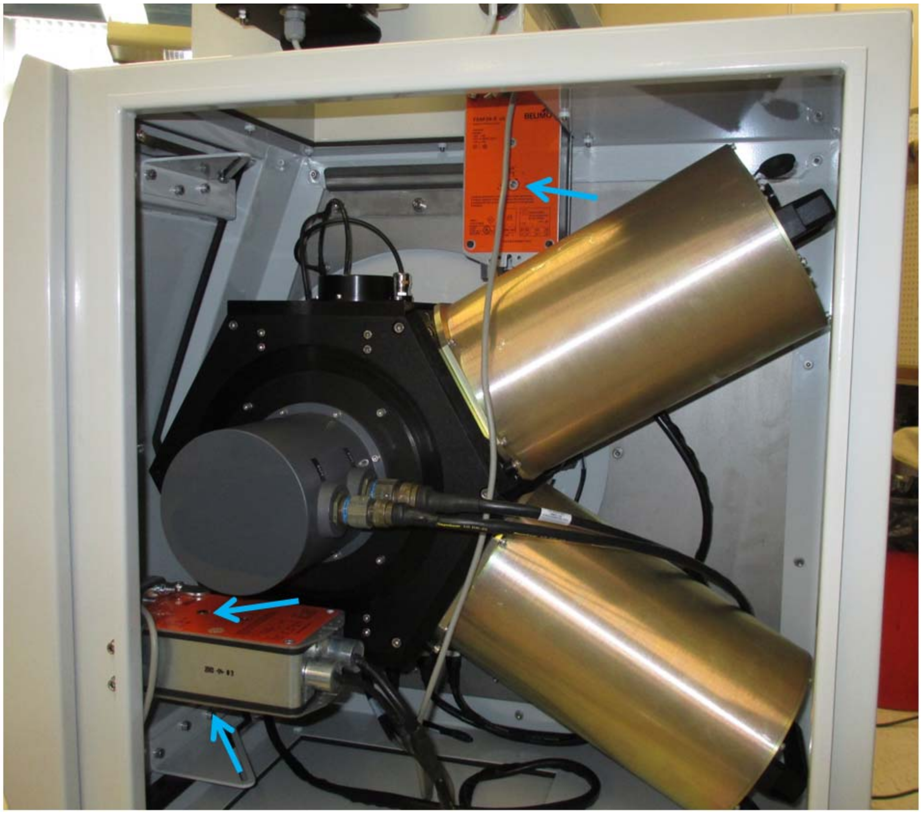

Figure F- 21. Hatch opening mechanisms

Figure F- 22. Close-up of hatch mechanism

3. Turn the hexagonal key counterclockwise to open the hatch. The motor can be locked in OPEN position by turning the hexagonal key clockwise.
4. Unlock the motor close the hatch.

	The hatch mechanism is very strong and stiff. Extreme caution must be paid when working around this component.The hatch located on top of the enclosure opens and closes electrically. Avoid putting any objects or body parts as it may damage the hatch and cause serious injuries.

How to access the back-end enclosure

To perform the maintenance procedures in section 7, the user needs to access inside the back-end enclosure.

Temperature Control Unit

The temperature control unit located on the back panel of the back-end enclosure is a door that can be opened by turning the two latches located on the right side of the door. You can pivot the door and even remove it if necessary, the door is fixed with lift-off hinges. Before lifting the door to remove it, make sure to disconnect the power and Ethernet cables connected to an interface plate inside the enclosure. Disconnect also the temperature control communication cable.

Back-End Enclosure

Top and sides covers can be removed to access the back-enclosure. Unlatch the cover, open it and before removing it completely, locate the ground connection and disconnect it to release the cover.

How to make visual inspection of the M-AERI scene mirror

To perform a visual inspection of the scene mirror, proceed as follows:

1. Close ingest software if it is running on the laptop.
2. Open FTSW E-AERI in Interface mode. Refer to Operation on page 53. The software will connect to the AERI system and the hatches will open.
3. On the Measurements tab, select Custom angle in the Mirror position field. Enter an angle between 45 and 135 degrees, the mirror will rotate to a position on the side viewing port if it is located on the left when facing the front-end. Enter an angle between 225 and 315 degrees if the side viewing port is located on the right.
4. Perform the visual inspection of the scene mirror.
5. Close FTSW E-AERI software and return to normal operation.

Packing Instructions

Put the instrument on its dolly, align the shockmounts with the holes on the frame and fix the shockmounts with the screws.

Slide the box covers on the dolly and close the latches. Re-install on the pallet and the wooden box.

System Specifications

Weight

Travel box empty	147 kg (325 lb)
Dolly	77 kg (170 lb)
Accessories Box	14 kg (31 lb)
M-AERI	278 kg (613 lb)
Box complete with M-AERI	355 kg (783 lb)
Accessories Box complete	26 kg (57 lb)
Complete M-AERI system in travel case and inside wooden box (150x117x168 cm / 59"x46"x66")	515 kg (1135 lb)

Dimensions

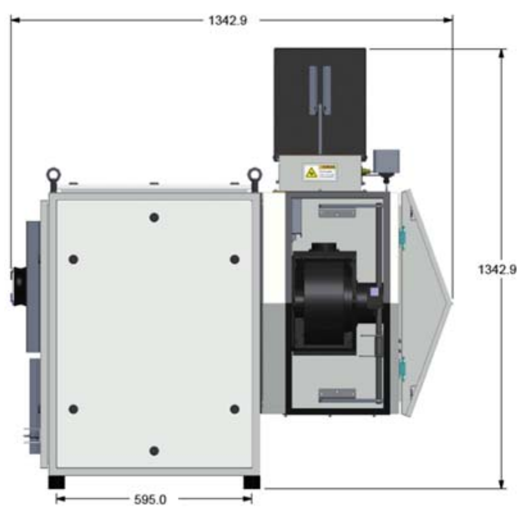

Figure F- 23. Overall dimensions

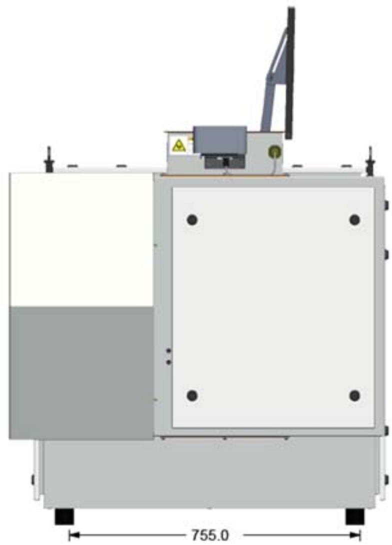

Figure F- 24. Overall dimensions

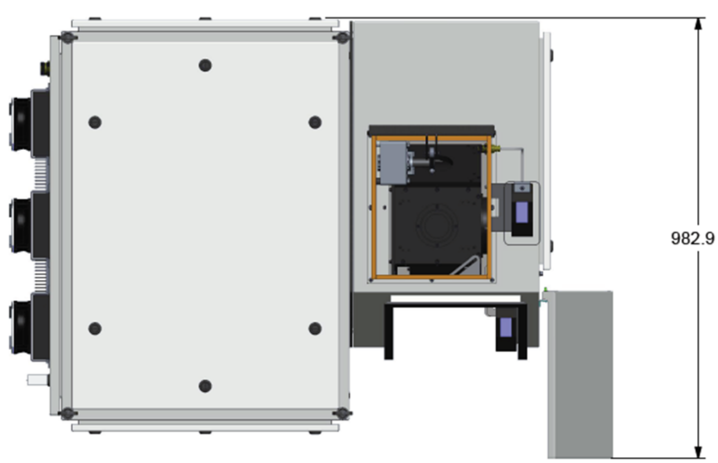

Figure F- 25. Dimensions top view